

DEPARTMENT OF COMMERCE

CIRCULAR

OF THE

BUREAU OF STANDARDS

S. W. STRATTON, DIRECTOR

No. 13

STANDARD SPECIFICATIONS FOR INCANDESCENT ELECTRIC LAMPS

[Tungsten (or Mazda) and Carbon]

[8th Edition]

ISSUED APRIL 13, 1918

[Superseding 7th Edition, issued October 23, 1915]



PRICE, 5 CENTS

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INTRODUCTORY STATEMENT

An informal conference called by the engineers of the various Government departments, and attended by them, by representatives of the manufacturers of incandescent lamps in the United States, and by representatives of the Bureau of Standards and the Electrical Testing Laboratories, was held in Washington, February 25 to 27, 1907, at which specifications for electric incandescent lamps, then including only the carbon class, were adopted. At a meeting held at the Bureau of Standards, May 13, 1908, various modifications were adopted, and at a third conference at the Bureau, May 14, 1909, the specifications were again revised, and metallized filament, tantalum, and tungsten lamps were included in the general specifications and separate schedules prepared for each class of lamp.

The fourth annual conference was held in Washington April 28, 1910, when the specifications and schedules were revised, and carbon lamps were placed upon the same basis as the other classes, namely, a rating in watts instead of in candlepower. The specifications were not revised in 1911, because of the important changes then in progress in the manufacture of tungsten lamps.

No general conference of the lamp manufacturers and Government engineers has been held since 1910, but the general specifications and schedules were thoroughly revised in April, 1912, after informal conferences between representatives of the Bureau of Standards and representatives of various departments of the Government, and after consulting with representatives of various lamp manufacturers. Three further revisions have been made by the Bureau after consulting with representative manufacturers—one in the autumn of 1913 for the sixth edition of this circular, another in August, 1915, for the seventh edition, and the latest in December, 1917, for the present (eighth) edition. As a result of the 1915 revision only two classes of lamps, namely, tungsten (or Mazda) and carbon, are included in these specifications, but in the present edition the tungsten (or Mazda) schedule has been enlarged by the addition of gas-filled lamps of the 110 to 125 volt range. The carbon-lamp schedule has been retained because

these lamps still properly find a considerable application, particularly in service where the renewal cost of tungsten (or Mazda) lamps would be excessive on account of an unusual amount of theft or breakage.

Criticisms and suggestions concerning these specifications and lamp ratings are invited from both manufacturers and users of lamps. All such suggestions will be carefully considered when the specifications are again revised.

Although these specifications have been prepared primarily for the use of the departments of the Government in purchasing incandescent lamps, it seems desirable, on account of the thoroughness with which the subject has been studied and discussed, that the specifications should be available to the general public. In circulating them freely, however, the Bureau desires to call attention to the necessity of extreme caution in the application of the tests described. Only those thoroughly instructed in the art of lamp manufacture and in the science of photometry should undertake to determine upon the acceptability of lamps under the terms of these specifications.

S. W. STRATTON,
Director.

I. GENERAL SPECIFICATIONS¹

1. GENERAL CONDITIONS

Incandescent lamps to be furnished shall be new lamps and shall conform to the following specifications.

The provisions of these specifications shall apply to all lamps specifically mentioned herein, and to no other lamps, except by mutual written agreement between the purchaser and the manufacturer.

These specifications shall not apply to frosted or colored lamps or to lamps other than those with the usual clear glass bulbs, unless otherwise specifically included. Lamps to be frosted may be inspected after frosting, but shall not be represented on life test by frosted lamps.

All tests shall be made in a competent and expert engineering manner at the expense of the purchaser, excepting that when initial tests and inspections are made at the factory the manufacturer will be required to supply the necessary equipment, assistance, current, and facilities for making such initial tests and inspections. The manufacturer shall have the privilege of witnessing and verifying all tests of his lamps made hereunder, and shall also have the privilege of obtaining copies of the results of the tests of his lamps and to have access to the records of such tests at all reasonable times. Prompt notice of the results of lamp tests will be given the manufacturer.

2. DEFINITIONS AND STANDARDS

(a) *Electrical Units.*—The values of the electrical units in these specifications are those which have been in force since January 1, 1911.

(b) *Unit of Candlepower.*—The unit of candlepower shall be the international candle as maintained by the Bureau of Standards at Washington, D. C.

(c) *Photometric Measure.*—The basis of comparison for all lamps shall be total flux expressed in lumens, or spherical candlepower. In the case of vacuum lamps the initial lumens or spherical

¹ Complete specifications for incandescent electric lamps include both the "General specifications" and the "Lamp schedules" attached thereto.

candlepower may be calculated from measured values of the mean horizontal candlepower by employing initial spherical reduction factors given in the schedules for the several classes of lamps.

Allowance shall be made for such changes as may occur in spherical reduction factors during life tests of all lamps.

For lamps having filaments giving an initial ratio of mean spherical to mean horizontal candlepower different from the values given in the schedules the horizontal candlepower measurements shall be corrected by an initial spherical reduction factor determined by the Bureau of Standards or other authority mutually agreed upon, and the life-test values shall be equivalent to those given in the schedules.

(d) *Test Quantity*.—The test quantity shall consist of 5 per cent of each lot of lamps inspected of any one type, size, and voltage range of any class, and in no case shall be less than 10 lamps.

The inspector may select as a lot of lamps to be inspected any individual package or any group of packages containing one type, size, and voltage range of any one class.

The lamps comprising the test quantity shall be selected proportionately from the several packages composing the lot, and shall be known as the test lamps.

(e) *Class*.—The term “class” is the distinguishing generic commercial designation. Two classes of lamps, namely, tungsten (or Mazda) and carbon, are covered by these specifications.

(f) *Style*.—Lamps are classified under two styles, namely, large and miniature. “Large style” designates broadly lamps regularly fitted with other than miniature bases. All lamps covered by these specifications are “large style.”

(g) *Type*.—The shape of the bulb determines the type (“straight-side type,” lamps having straight-side bulbs, such as S-19 or S-21; “round type,” lamps having round bulbs, such as G-18½ or G-25; “pear-shape type,” lamps having bulbs of pear shape, such as PS-22 or PS-52).

(h) *Size of Lamp*.—The size of incandescent electric lamps is expressed in nominal watts or nominal candlepower.

(i) *Size of Bulb*.—The size of bulb is expressed by a letter indicating the shape and a number defining the maximum diameter in eighths of an inch (S-17, straight-side bulb, $\frac{17}{8}$ or $2\frac{1}{8}$ inches maximum diameter; G-18½, round bulb, $2\frac{5}{8}$ inches in diameter; PS-25, pear-shape bulb, $3\frac{1}{8}$ inches in diameter).

(j) *Base*.—There are four groups of bases—miniature, candleabra, medium, and mogul. Medium screw bases are used on

lamps covered by these specifications except where mogul bases are indicated in the schedules.

(k) *Voltage Range*.—Voltage range is the total range of voltage within which lamps are supplied. These specifications include two voltage ranges, namely, 110 to 125, and 220 to 250.

(l) *Rated Voltage or Rated Current*.—The rated voltage or rated current of a lamp is the voltage or current indicated on the label.

(m) *Regular Lamps*.—Regular lamps are lamps whose construction conforms to that regarded as standard by the manufacturer. There are regular lamps of each style, but large style regular lamps only are covered by these specifications.

3. MECHANICAL AND PHYSICAL CHARACTERISTICS

(a) *Bulbs*.—All bulbs shall be uniform in size and shape, clear, clean, and free from flaws and blemishes detrimental to service.

(b) *Bases*.—Moisture-proof medium screw bases, fitted with glass buttons, shall be used on all lamps, unless otherwise specified, and when bases have extended skirts the latter shall be insulated from the screw shell. The bases shall be firmly and accurately fitted to the bulbs with moisture-proof cement. The shells and skirts of the bases shall be of brass of good quality.

(c) *Filaments*.—The filaments shall be uniform and free from imperfections, spots, and discolorations detrimental to service, and shall be symmetrically disposed in the bulbs.

(d) *Leading-in Wires*.—Leading-in wires shall be securely attached to the ends of the filaments, and shall be securely attached without excess of solder to the terminals of the base which make contact with the socket. The threads of the base shall be free from solder.

(e) *Vacuum*.—Vacuum lamps shall show the characteristic glow for each class, size, and voltage range when tested on an induction coil.

(f) *General*.—The lamps shall be well made and free from all defects and imperfections, so as to meet satisfactorily the conditions of the lighting service.

All lamps shall conform to the manufacturer's standard shapes and sizes of bulbs, to the manufacturer's standard forms of filament, and to the manufacturer's standard ratings.

(g) *Marking*.—One or more labels, showing the rating and the manufacturer's name or trade-mark, shall be placed on the bulb or the base of each lamp.

4. METHOD OF INITIAL INSPECTION AND TESTS

(a) *Selection of Lamps for Initial Test.*—From each lot of lamps there shall be selected at random the test quantity for the purpose of determining the mechanical and physical characteristics of the lamps, the individual limits as provided in the schedules, and, finally, the life and the candlepower maintenance.

The manufacturer may present for initial test tungsten (or Mazda) lamps which have not been sufficiently burned, or “aged,” to have reached stable values of wattage or candlepower. The manufacturer shall arrange for the proper “aging” of such lamps as are selected for initial limits test.

(b) *Rejection for Mechanical and Physical Defects.*—The test quantity selected from any lot of lamps shall be inspected for physical defects, and when so inspected, if the number of lamps showing physical defects incompatible with good workmanship, good service, or with any clause of these specifications, is equal to or in excess of the percentage or quantity necessary for rejection given in their respective schedules, the entire lot of lamps from which the test quantity was selected may be rejected without further test, unless the individual schedules provide otherwise.

(c) *Rejection for Defective Rating.*—Lamps shall be tested at rated voltage, current, or candlepower as shown in the schedules, and when so tested, if the number of lamps in any lot, falling beyond the limits given, equals or exceeds the percentage or quantity necessary for rejection as given in the schedules, the entire lot of lamps from which the test quantity was selected may be rejected without further test, unless the individual schedules provide otherwise.

(d) *Selection of Lamps for Life Test.*—For the purpose of selecting lamps for life test accepted packages containing 100 lamps or less may be grouped to aggregate not more than 250 lamps. From such groups, and from accepted standard packages containing more than 100 lamps each, at least one sample shall be selected which approximates most closely to the average of the test quantity. The lamp thus selected shall be designated as the life-test lamp, and will be subjected to a life test. A second or duplicate lamp may be reserved to replace this life-test lamp, in case of accidental breakage or damage during life test. The life-test lamps shall be rated and operated on life test as shown in their respective schedules.

5. LIFE AND CANDLEPOWER MAINTENANCE

(a) *Life-Test Voltages.*—Life-test lamps shall be operated on the life-test rack at voltages (or currents) corresponding to the test watts per spherical candle given in the tables under the heading “average performance” or to the test watts per spherical candle agreed upon, as provided in the schedules.

(b) *Candlepower Measurements.*—During life test carbon lamps shall be read for candlepower and current at the test voltage at approximately 50 hours, and at least every 100 hours thereafter until the candlepower shall have fallen 20 per cent below the initial candlepower, or until the lamp breaks, if within that period. Tungsten (or Mazda) lamps shall be read for candlepower and current at the test voltage at approximately one-twentieth of the test-life period corresponding to the test watts per spherical candle, and thereafter at such intervals as shall afford approximately five determinations until the average candlepower shall have fallen 20 per cent below the initial candlepower, or until the lamp breaks, if within that period.

(c) *Test Life.*—The number of hours each lamp burns until the candlepower has decreased to 80 per cent of its initial value, or until the lamp breaks, if within that period, is known as the test life.

Lamps which are accidentally broken but not burned out on test, shall not be counted to diminish the average performance.

In case any life-test lamps are broken or damaged before the life test is completed, the average performance of all lamps of the same class, size, etc., tested under the same contract shall be assigned to the package represented.

On all life tests for determining test life and candlepower each package or group of packages which will be affected by the results of the test shall have at least one lamp on such test.

(d) *Voltage Regulation.*—Accurate recording voltmeter records shall be obtained during the life test on lamps to show the variation of the voltage on the circuit.

Variations of voltage are not to exceed one-quarter of 1 per cent above and below the test voltage.

6. REJECTIONS AND CANCELLATION OF CONTRACT

(a) *Conditions for Rejection.*—The failure of the lamps to conform to the specifications as to mechanical and physical characteristics, or to initial limits, may cause their rejection.

Any group of the lamps initially inspected may be rejected, provided such group is represented on life test by at least four lamps which give an average test-life value less than the test-life value specified in their respective schedules, except that for carbon lamps 90 per cent of this value will be used.

(b) *Return of Rejected Lamps*.—Lamps which have not been used and are rejected under the terms of these specifications may be returned to the manufacturer at his expense, and no payment made therefor. All lamps placed in service shall be considered as accepted.

(c) *Cancellation of Contract*.—A contract for lamps furnished under these specifications may be canceled in the event that the average actual test-life values determined up to any given time are less than the test-life values given in the schedules, except that for carbon lamps 90 per cent of these values will be used.

Under paragraphs (a) and (c) of this section the allowance of 10 per cent on carbon lamps is made because the present initial rating of carbon lamps is probably a limiting value.

The foregoing paragraphs provide specifications that are general for tungsten (or Mazda) and carbon lamps, and, when accompanied by the schedule for either of these classes of lamps, form the complete specifications for that class.

II. LAMP SCHEDULES

Schedule A.—TUNGSTEN (OR MAZDA) LAMPS

This schedule applies to large, clear, tungsten (or Mazda) lamps of from 110 to 125 volts and from 220 to 250 volts for multiple burning, and, with the General Specifications for incandescent electric lamps, forms complete specifications for lamps of such sizes and in such bulbs as are specifically mentioned herein.

QUANTITY NECESSARY FOR REJECTION

When tested at the factory, any package or lot may be rejected in the event of failure of 20 per cent or more of the test lamps to conform to the initial limits, or in the event of 20 per cent or more of the test lamps showing physical defects.

When tested elsewhere, any package or lot may be rejected when 30 per cent or more of the test lamps fail as above.

TABLE A.—Limits, Rating, and Life Performance

VALUES FOR CLEAR 110 TO 125 VOLT VACUUM TUNGSTEN (OR MAZDA) LAMPS FOR MULTIPLE BURNING

Size of lamp in watts ^a	Bulb designation	Rated initial watts per spherical candle ^b	Correspond- ing initial watts per mean horizontal candle.	Initial limits at rated voltage		Average performance Test life in hours to 20 per cent drop in candlepower at rated initial watts per spherical candle ^c
				Individual watts per spherical candle, maximum and minimum	Individual total watts, maximum and minimum	
10	S-17	1.67	1.30	Per cent 8	Per cent 10	1000
15	S-17	1.51	1.18	6	8	1000
25	S-19	1.41	1.10	6	8	1000
40	S-19	1.35	1.05	6	8	1000
50	S-19	1.33	1.04	6	8	1000
60	S-21	1.31	1.02	6	8	1000
100	S-30	1.25	.98	6	8	1000

VALUES FOR CLEAR 220 TO 250 VOLT VACUUM TUNGSTEN (OR MAZDA) LAMPS FOR MULTIPLE BURNING

25	S-19	1.65	1.30	9	12	1000
50	S-19	1.49	1.18	9	12	1000
100	S-30	1.39	1.10	9	12	1000

VALUES FOR CLEAR 110 TO 125 VOLT GAS-FILLED TUNGSTEN (OR MAZDA) LAMPS FOR MULTIPLE BURNING

75	PS-22	1.09		15	13	e 1000
100	PS-25	1.00		12	18	e 1000
150	PS-25	.92		12	15	e 1000
200	PS-30	.86		12	15	e 1000
d 300	PS-35	.78		12	15	e 1000
d 400	PS-40	.82		12	12	e 1000
d 500	PS-40	.78		12	12	e 1000
d 750	PS-52	.74		12	12	e 1000
d 1000	PS-52	.70		12	12	e 1000

^a Average initial spherical reduction factors for 110 to 125 volt lamps, 78 per cent; for 220 to 250 volt lamps, 79 per cent.

^b On receipt of written notice from the manufacturer, any or all of the initial rated watts per spherical candle shown in the table may be numerically increased by not to exceed 5 per cent or decreased by not to exceed 10 per cent. The initial limits and test-life performance specified in the table shall apply to the lamps at the changed rating.

^c At the option of the purchaser life tests may be made at special watts per spherical candle mutually agreed upon by the manufacturer and the purchaser.

^d Fitted with mogul bases.

^e Although the average test life of gas-filled lamps covered by this table is expected to be 1000 hours when tested to 80 per cent of the initial candlepower, until further notice such lamps shall not be rejected if the test life is not less than 1000 hours when tested to 75 per cent of the initial candlepower.

All lamps burned out during life test must have burned out with current on them and without shock in order to be included in the test and be counted to reduce the average life-test performance.

Lamps broken in handling or when current is not on them shall not be counted to reduce the average life-test performance.

Gas-filled lamps shall be operated on life test in a vertical position, tip downward.

The labels on the lamps shall show the nominal total watts and voltage.

Schedule B.—CARBON MULTIPLE LAMPS

This schedule applies to large, regular, clear, carbon lamps from 110 to 125 volts and from 220 to 250 volts, for multiple burning, and, with the General Specifications for incandescent electric lamps, forms complete specifications for lamps of such sizes as are specifically mentioned herein.¹

QUANTITY NECESSARY FOR REJECTION

When tested at the factory, any package or lot may be rejected in the event of failure of 20 per cent or more of the test lamps to conform to the initial limits, or in the event of 20 per cent or more of the test lamps showing physical defects.

When tested elsewhere, any package or lot may be rejected when 30 per cent or more of the test lamps fail as above.

Values for Excepted Voltages.—Lamps in this schedule, of rated voltages 110, 121 to 125, inclusive, and also 220, may have double the limits of variation in the initial limits at rated voltage specified for their respective sizes.

¹ Although it appears desirable to retain this schedule applying to carbon lamps, attention is directed to the fact that the use of these lamps is economical only under exceptional circumstances. The reduction in current consumption effected by the substitution of tungsten (or Mazda) lamps for carbon lamps of equivalent candlepower will usually repay manyfold the difference in cost of lamps. In making this substitution, however, it will often be found advisable not to take full advantage of the possible reduction in current consumption, but rather to make a moderate saving in current and to allow a considerable increase in the amount of light provided.

A more detailed discussion of the advantages of using the newer types of lamps is given in Circular No. 55 of this Bureau.

TABLE B.—Initial Limits, Rating, and Performance

VALUES FOR CLEAR, OVAL-ANCHORED, 110 TO 125 VOLT REGULAR CARBON LAMPS FOR MULTIPLE BURNING

Size of lamp in watts ^a	Initial mean horizontal candlepower at rated voltage	Initial limits at rated voltage				Average performance
		Individual candlepower limits	Mean candlepower limits	Individual watt limits	Mean watt limits	Test life in hours to 20 per cent drop in candlepower at 3.70 watts per spherical candle
20	4.8	1 cp above and 1 cp below	0.6 cp above and 0.6 cp below	12 per cent above and 12 per cent below	6 per cent above and 6 per cent below	300
25	8.1	do.....	do.....	10 per cent above and 10 per cent below	5 per cent above and 5 per cent below	300
30	9.3	do.....	do.....	do.....	do.....	350
50	16.8	7.5 per cent above and 7.5 per cent below	2.5 per cent above and 2.5 per cent below	5.5 per cent above and 5.5 per cent below	2.5 per cent above and 2.5 per cent below	450
60	20.2	do.....	do.....	do.....	do.....	420

VALUES FOR CLEAR, DOUBLE OVAL-ANCHORED, 220 TO 250 VOLT REGULAR CARBON LAMPS FOR MULTIPLE BURNING

35	8.0	2 cp above and 2 cp below	1 cp above and 1 cp below	15 per cent above and 15 per cent below	7.5 per cent above and 7.5 per cent below	120
60	16.3	15 per cent above and 15 per cent below	7.5 per cent above and 7.5 per cent below	12 per cent above and 12 per cent below	6 per cent above and 6 per cent below	160

^a Average spherical reduction factor, 82.5 per cent.

NOTE.—*Excepted voltages.*—It is recommended that every effort be made to avoid ordering lamps of actual rated voltages 110, 111, 121 to 125, inclusive, and 220.

For lamps of rated voltages between 120 and 125, inclusive, the test-life values shall be 95 per cent of those given in Table B.

Lamps in this schedule should burn on life test in one horizontal position at a voltage corresponding to an initial specific consumption of 3.70 watts per spherical candle without excessive drooping of the filament.

The labels on the lamps shall show the nominal total watts and voltage.



